

Narrow Fe K α Emission in Seyfert Galaxies

Jane Turner
UMBC-JCA & NASA-GSFC

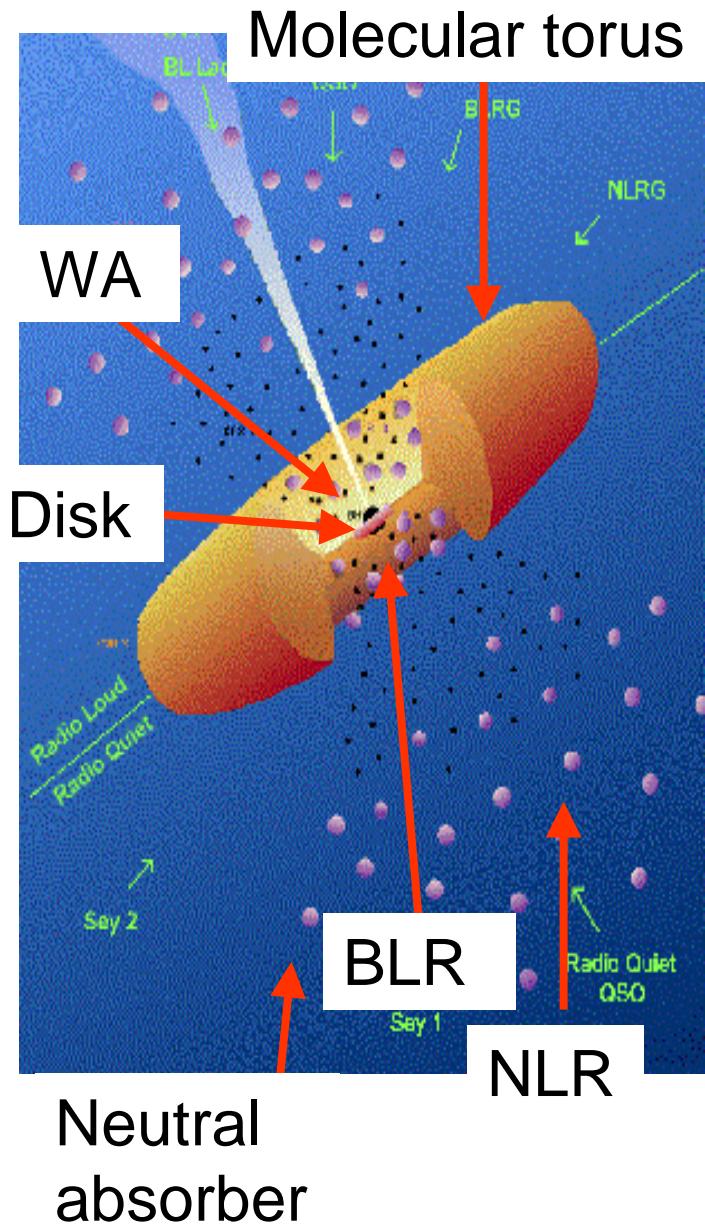
*with James Reeves, Steve Kraemer,
Ian George, Tahir Yaqoob*

Fe K α production

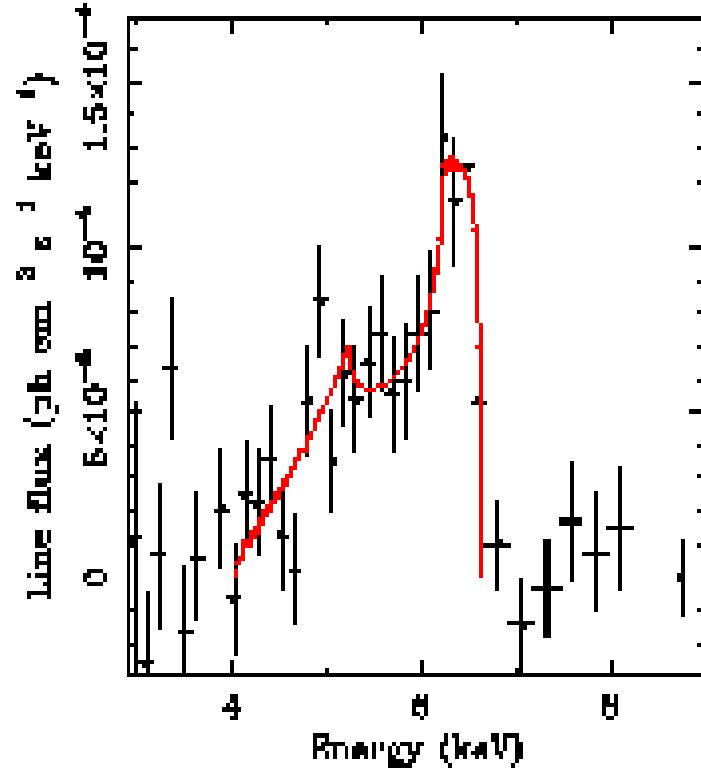
Fe K α prominent -high abundance/fluorescence yield

HEG - best spectral resolution ever @ 6.4 keV (39 eV, FWHM 1860 km/s)

Widths, energies
→ line origin

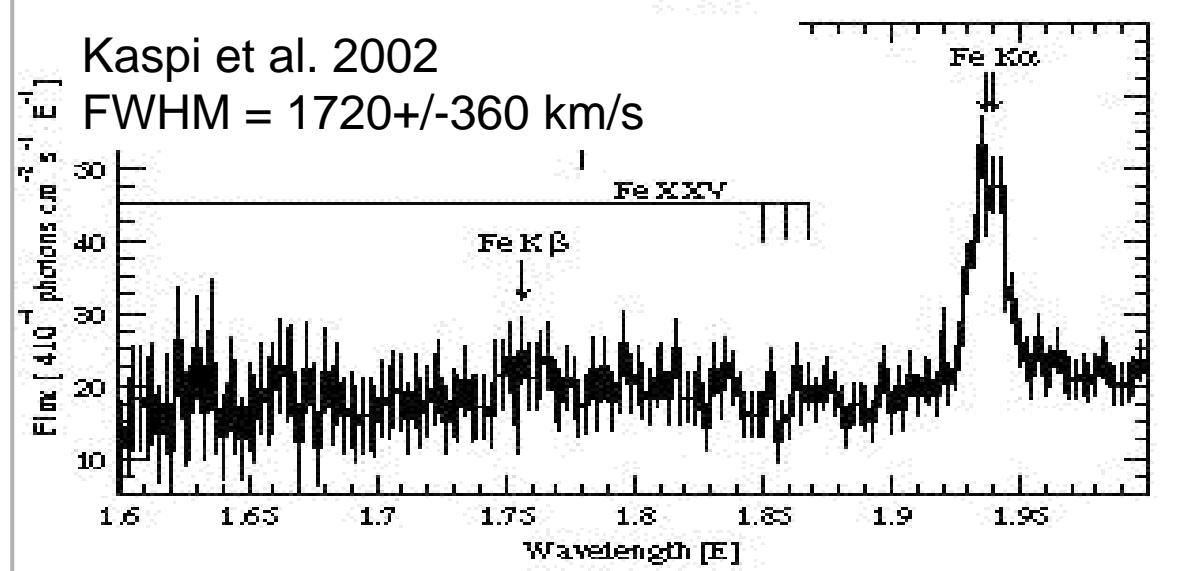


Fe K lines broad,
asymmetric -**dominated**
by disk contributions?
(Nandra et al 1997)



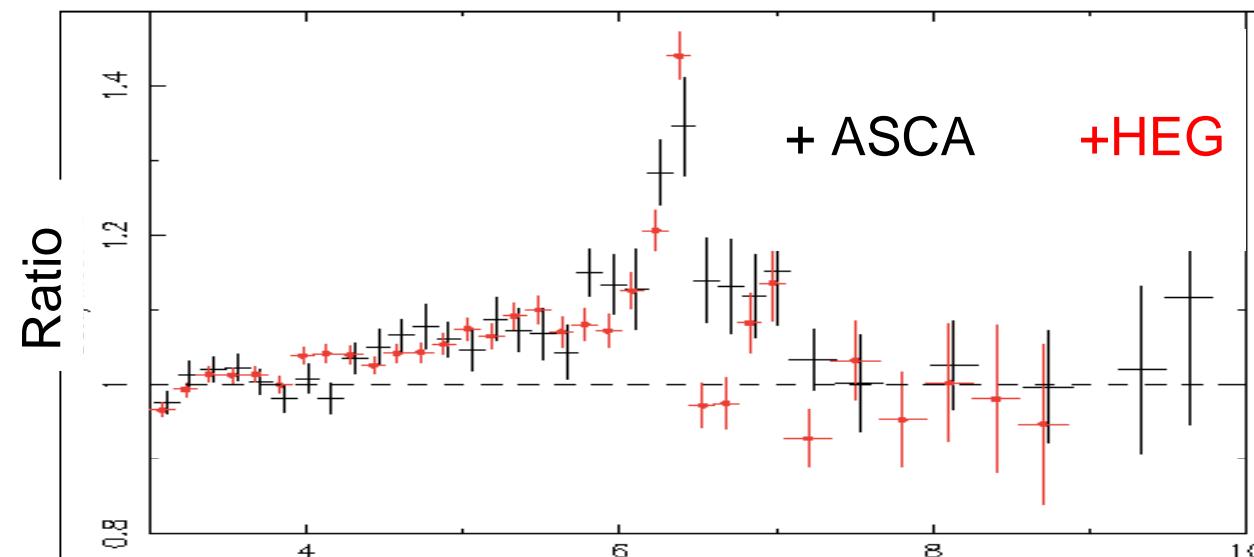
Tanaka et al 1995

HEG - NGC 3783

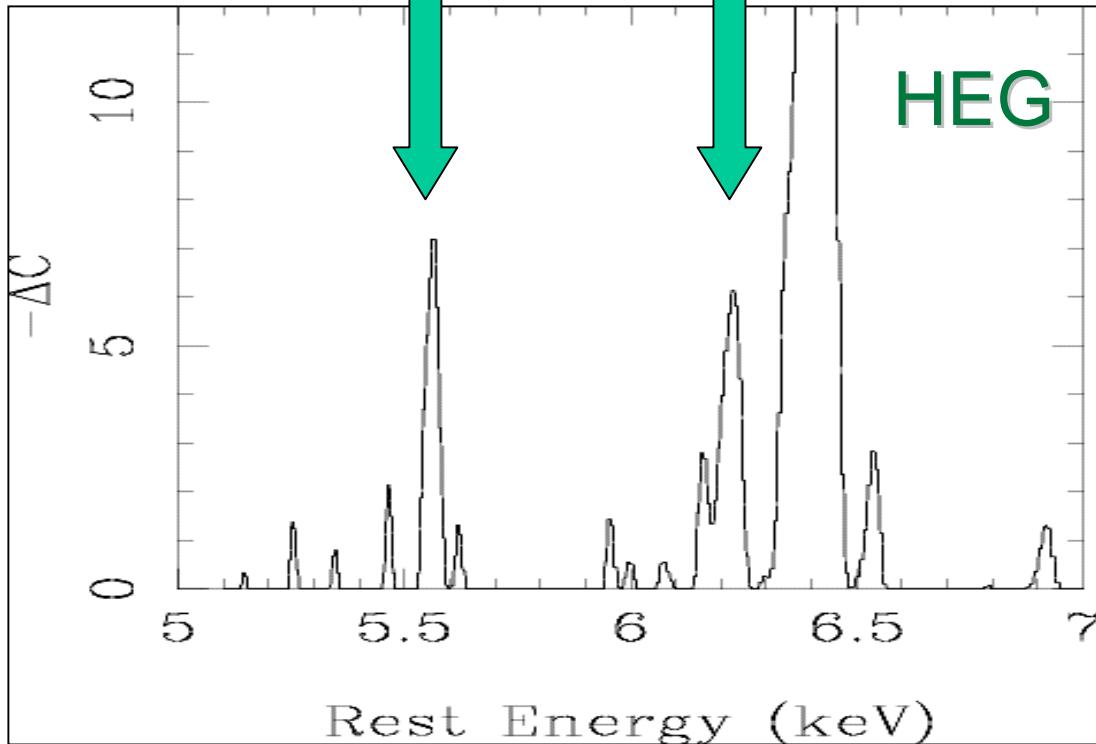


Initial Results:
narrow core
common

FWHM \rightarrow outer
BLR



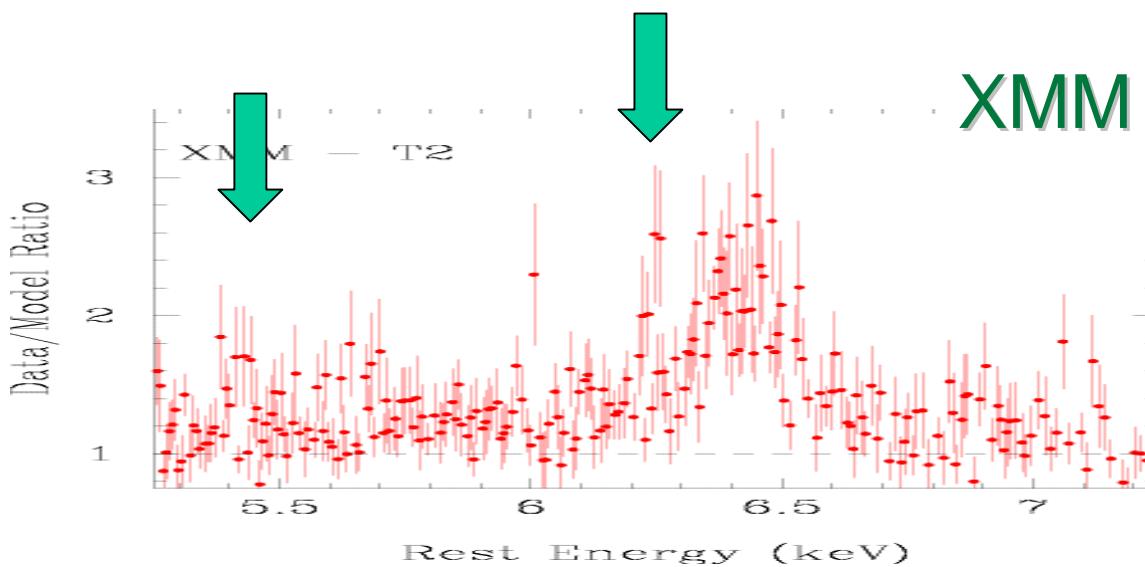
BL confirmed
...all as expected



NGC 3516
Turner et al '02

Unexpected lines @
5.6, 6.2 keV -
redshifted Fe

XMM confirmed &
showed variable
fluxes on ~ ten ks



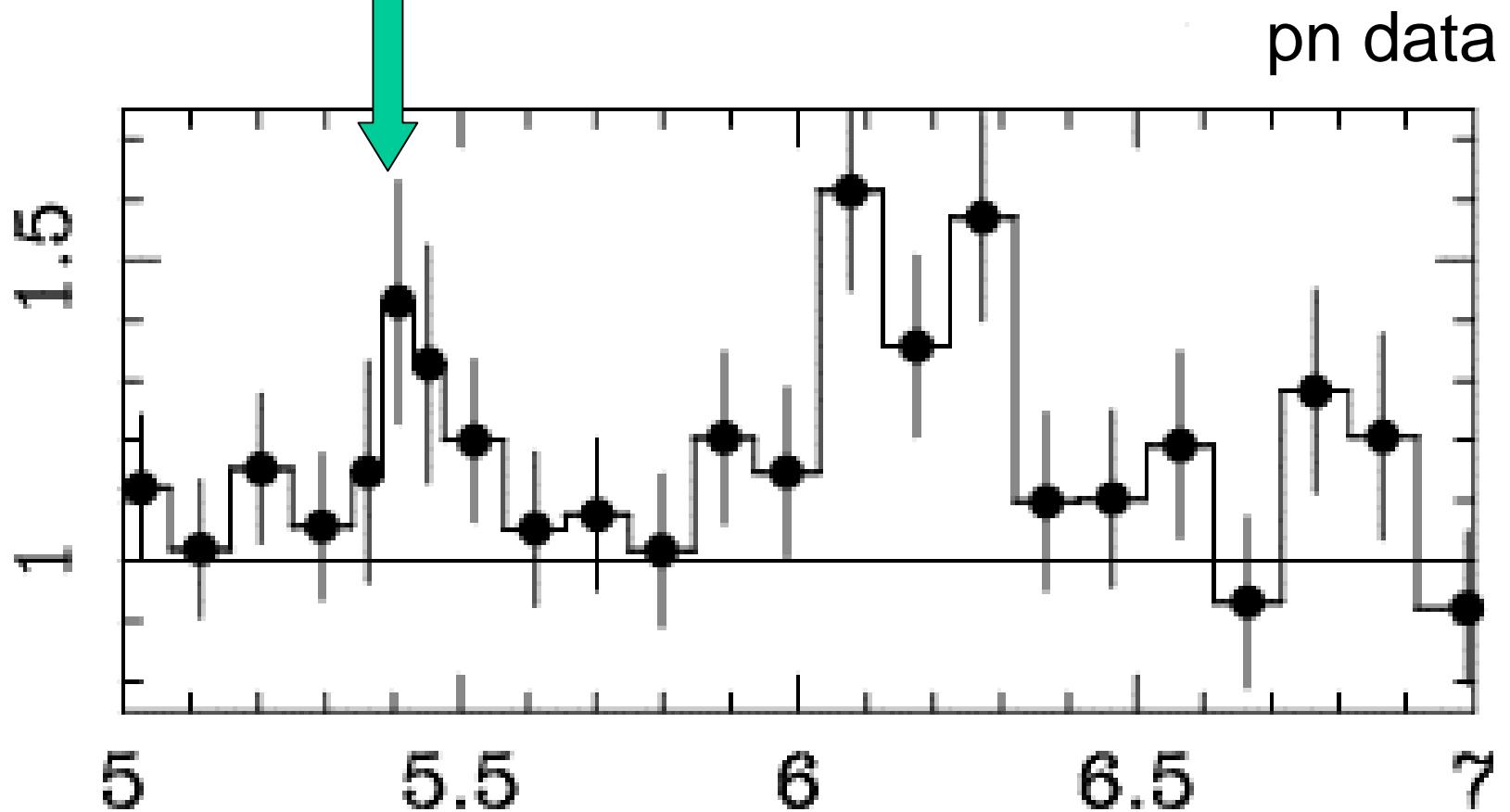
Narrow annuli on
disk, lit by magnetic
flares?

Should have stronger
blue horns

Similar line in ESO198-G24 (Guainazzi 2003)

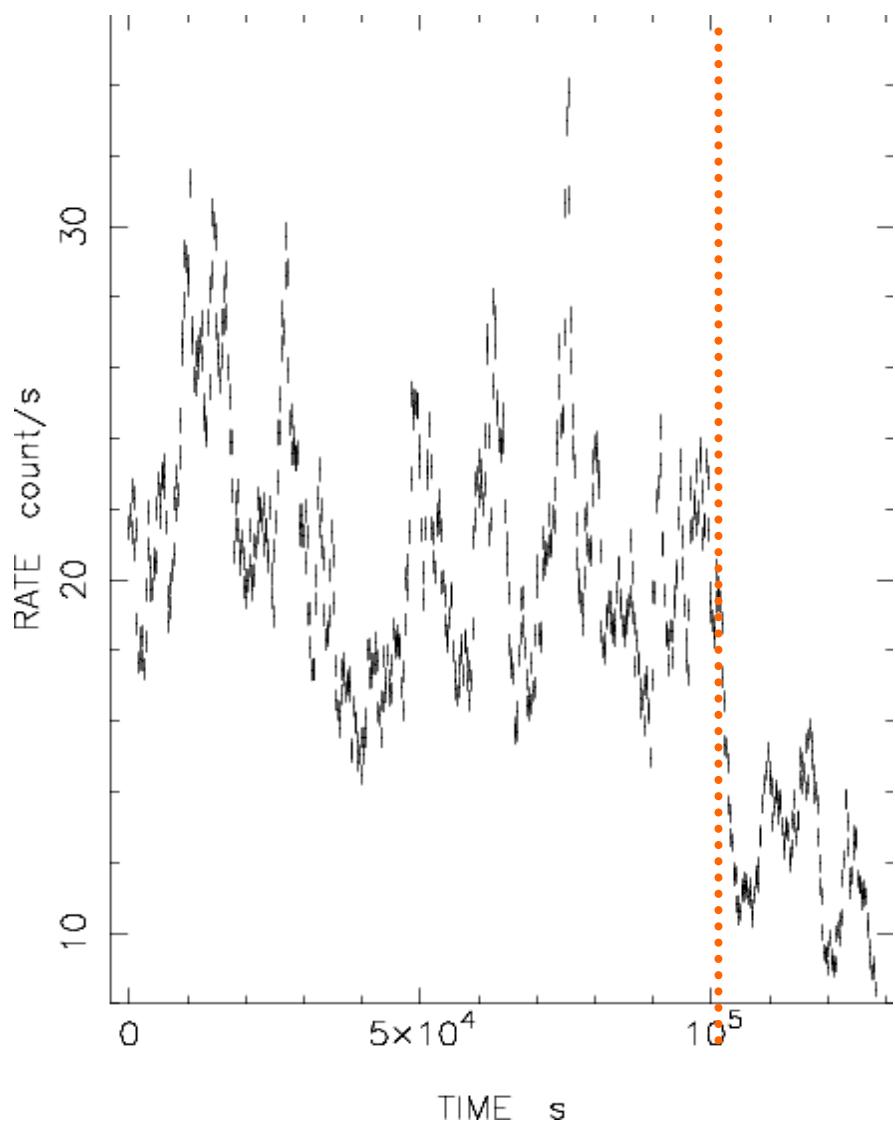
$E_{\text{obs}} = 5.4 \text{ keV}$

$E_{\text{rest}} = 5.7 \text{ keV}$

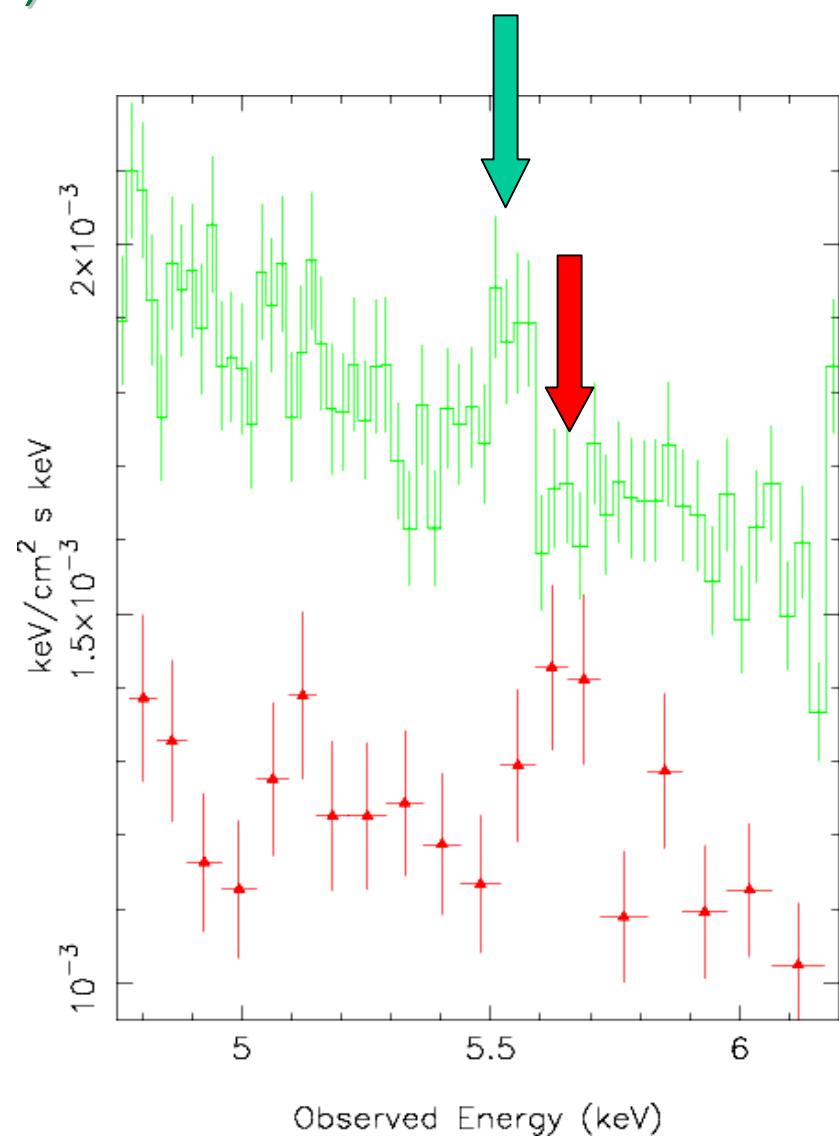


& NGC 7314 $E_{\text{rest}} = 5.9 \text{ keV}$ (Yaqoob et al 2003)

Mkn 766 (XMM) - Turner et al 2003



EPIC light curve

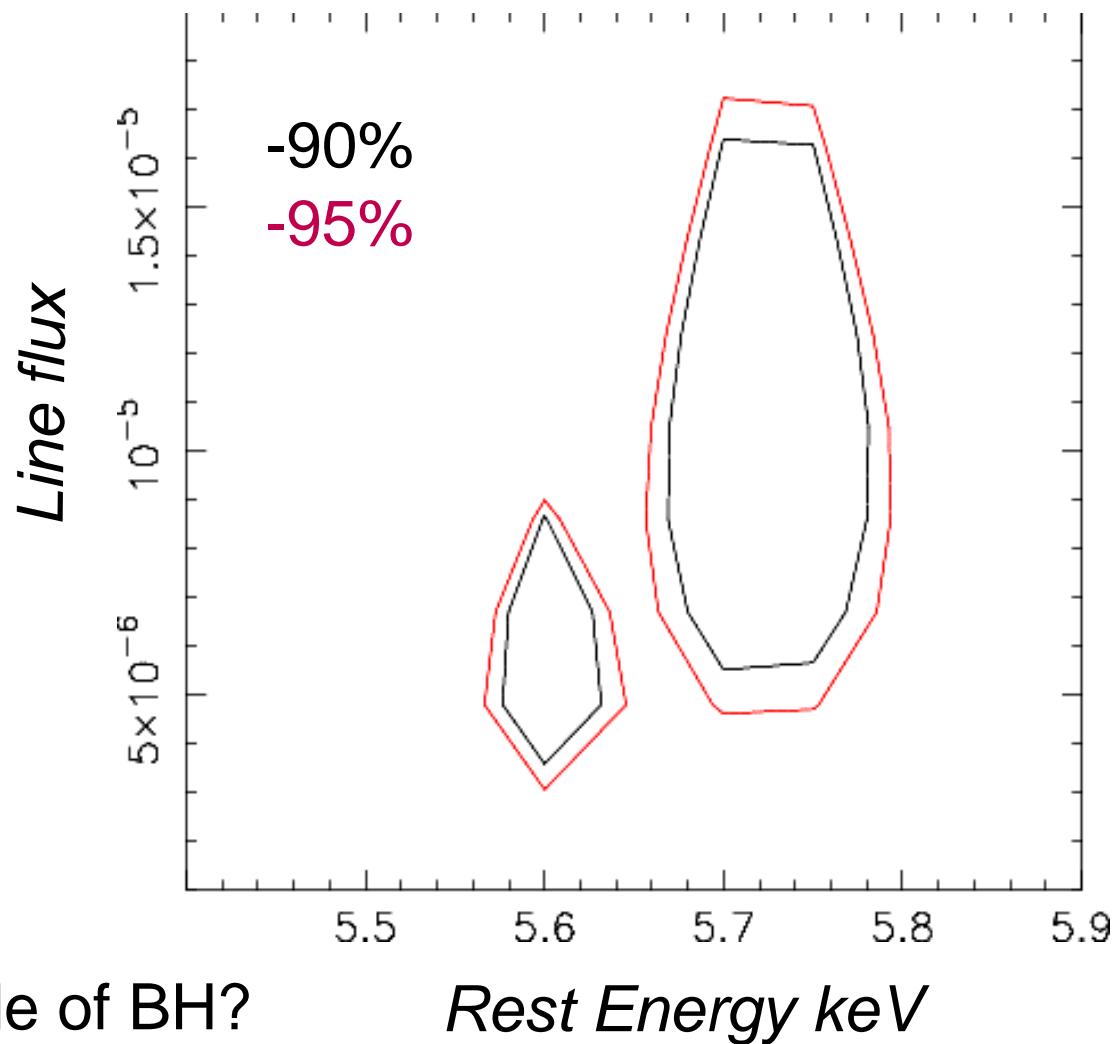


EPIC spectra

Markarian 766

Shift 5.60 -> 5.75
keV in ~ tens of ks

Deceleration (neutral
Fe) 37,500 -> 30,500
km/s



Outflowing blob, far side of BH?

Rest Energy keV

Magnetic fields /pressure gradients drive expulsion, blob
slowed by gravity

Decelerating blobs: Mkn 766

$dV=7000 \text{ km/s}$ in $dt \sim 65,000 \text{ s}$

$$dV/dt = GM/R^2$$

$M_{\text{BH}} \sim 10^7 M_{\odot}$ (Wandel 2000)

Radius at which blob exists $R \sim 3.5 \times 10^{14} \text{ cm}$

Escape velocity at this radius $V_{\text{esc}} \sim 28,000 \text{ km/s}$

Outflow 30,000 km/s slightly greater than escape vel

Decelerating blobs

Application of same arguments to tentative shift (5.4-5.6 keV) in NGC 3516, $R \sim 3.7 \times 10^{14}$ cm (!)

$\rightarrow V_{\text{esc}} \sim 41,000$ km/s cf $V_{\text{obs}} \sim 47,000$ km/s

Mkn 766 / NGC 3516 pass sanity check for outflow model

Spectra consistent w/ blueshifted lines (self-absn possible)

Other Info (Mkn 766):

Line EWs ~ 15 eV

$\Omega/2\pi \sim 0.1$

R & $N_H \rightarrow$ outflow $\sim 10^{-4} M_\odot$

K.E. in outflow $\sim 10^{48}$ ergs, few % of energy in the system at these radii

SUMMARY

- Narrow lines at unexpected energies - redshifted Fe
- Line shows rapid energy shift in Mkn766
- Expelled blobs of gas exceeding escape vel on far side of BH